

Application No. 10/604,368
Technology Center 1762
Amendment dated January 18, 2007
Reply to Office Action dated October 18, 2006

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Amendments to the Specification:

Please replace paragraph [0004] with the following amended paragraph:

[0004] In addition to modifying the chemistry of NiAl-base environmental coatings and bond coats, investigations have been undertaken to determine the effect that the surface finish of beta-phase NiAl overlay coatings has on their oxidation resistance and their ability to adhere a ceramic coating. Commonly-assigned U.S. Patent No. 7,150,922 ~~Application Serial No. 10/248,056~~ to Spitsberg et al. discloses a process by which the grain structure of a beta-phase NiAl overlay bond coat can be modified to improve the spallation resistance of a ceramic TBC deposited on the bond coat. The NiAl overlay coating is deposited by methods that produce a generally columnar grain structure, e.g., physical vapor deposition (PVD) techniques, with the result that open grain boundaries are typically present at the coating surface, with the grains physically separated thereby being referred to as leaders. For NiAl coatings of the type taught by the aforementioned U.S. Patent Nos. 6,153,313, 6,255,001 and 6,291,084, leaders are characterized by both a physical

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separation and chemical differences, and has been associated with reduced oxidation and spallation resistance as a result of providing a pathway for oxidation. To reduce the presence of deleterious leaders, Spitsberg et al. recrystallize the NiAl coating during or after deposition, resulting in the formation of new surface grain boundaries. Recrystallization is achieved by depositing the coating on a substrate maintained at a sufficiently high temperature so that recrystallization occurs during deposition, or by cold or warm working the coating surface and then heat treating the coating at a temperature sufficient to cause recrystallization.

Please replace paragraph [0007] with the following amended paragraph:

[0007] According to a first aspect of the invention, the oxidation resistance of an overlay coating of a type described above and the spallation resistance of a TBC deposited on the overlay coating can be improved by modifying the microstructure of the overlay coating. The overlay coating is first deposited on a substrate surface to have as-deposited grains that define as-deposited grain boundaries exposed at the outer surface of the overlay coating, at least some of

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which are open to the outer surface of the overlay coating. The overlay coating is then peened with a particulate media formed of a composition containing nickel and aluminum, followed by heating the overlay coating to a temperature sufficient to cause the overlay coating to recrystallize and form new grain boundaries that, though exposed at the outer surface of the overlay coating, are not open to the outer surface. In accordance with the aforementioned U.S. Patent No. 7,150,922 ~~Application Serial No. 10/248,056~~ to Spitsberg et al., the new grain boundaries exposed at the surface of the recrystallized overlay coating are significantly less susceptible to accelerated oxidation than are the original grain boundaries of the as-deposited overlay coating, such that the oxidation resistance of the overlay coating is improved.

Please replace paragraph [0017] with the following amended paragraph:

[0017] As discussed in the U.S. Patent No. 7,150,922 ~~Application Serial No. 10/248,056~~ to Spitsberg et al., the microstructure depicted in Figure 2 is more resistant to oxidation than the microstructure depicted in Figure 3, with the result that a TBC (the

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ceramic layer 26 in Figure 2) deposited on the bond coat 24 is more resistant to spallation. According to Spitsberg et al., oxidation occurs via the grain boundaries 44 along the grains 42, allowing for accelerated oxidation through the coating thickness. On this basis, improved oxidation resistance of an NiAl overlay bond coat, and therefore the spallation resistance of a TBC deposited on the bond coat, can be achieved by eliminating grain boundaries 44 that are open to the coating surface 36 and contain precipitates 40, particularly Zr-rich precipitates. In accordance with the teachings of Spitsberg et al., an equiaxed NiAl overlay bond coat of the type represented in Figure 2 can be achieved through bulk recrystallization of the bond coat during or following coating deposition, resulting in the elimination or "healing" of the leader grain boundaries 44 represented in Figure 3. For example, high deposition (substrate) temperatures on the order of about 1200°C and greater have been shown to cause bulk recrystallization during deposition with fewer open grain boundaries, yielding a bond coat similar to the bond coat 24 of Figure 2. Alternatively, improvements in oxidation resistance of a NiAl overlay coating can be achieved with coatings deposited at lower substrate temperatures, but then caused to recrystallize by

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appropriate post-deposition processing. For example, recrystallization can be induced by a surface mechanical treatment (e.g., peening) that introduces cold working into the bond coat, so that at least the surface if not the entire overlay coating undergoes recrystallization when sufficiently heated to drive the recrystallization process. In each case, improved oxidation and spallation resistance are attributed at least in part to the fewer number of precipitates (particularly Zr-rich precipitates in a Zr-containing NiAl coating) that decorate the grain boundaries of the recrystallized bond coat (Figure 2) as compared to the original columnar grain boundaries of the as-deposited NiAl bond coat (Figure 3).